Environmental Justice Screening Method:

Integrating Indicators of Cumulative Impact into Regulatory Decision-making

Source: CBE

Source: David Woo

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Jim Sadd, Occidental College

The Primary Research Team

- Manuel Pastor, Ph.D. in Economics, project coordination, statistical analyses, including multivariate and spatial modeling, and popularization
- James Sadd, Ph.D. in Geology, develop and maintain geographic information systems (GIS), including data automation, spatial analysis and geoprocessing
- Rachel Morello-Frosch, Ph.D. in Environmental Health Science statistical analysis, health end-points, and estimates of risk.

Purpose of Screening Methodology

- Develop indicators of cumulative impact that:
  - Reflect research on air pollution, environmental justice, and health
  - Are transparent and relevant to policy-makers and communities
  - Reviewed by community EJ groups, California Air Resources Board (CARB), academic peers and other agencies
- Apply EJ "screening method" to multiple uses:
  - Local land use planning
    - (e.g. Los Angeles, City of Commerce & Richmond – community plans)
  - Regulatory decision-making and enforcement
  - Community outreach

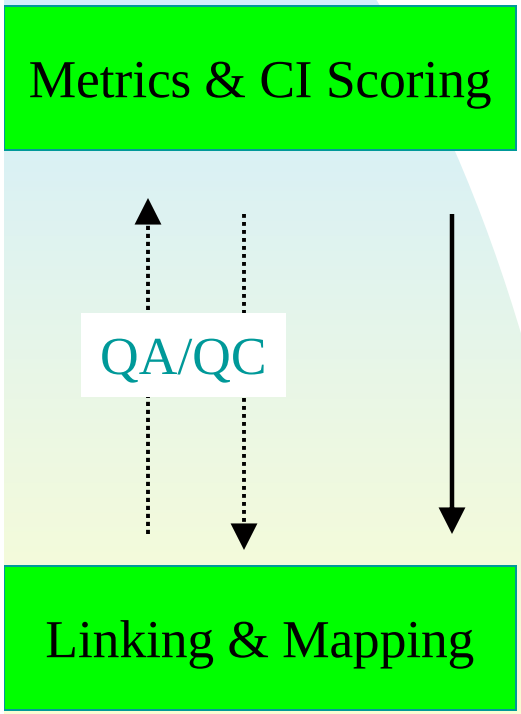
Focus of Screening Method

- Specific reference to ambient air quality
  - Not screening for occupational, indoor, water, pesticides.
  - Uses secondary databases (screening, not assessment)
  - Follows guidance of CARB Air Quality and Land Use Handbook (2005)
  - Validated by ARB contract Peer Review Committee
- Developed to incorporate land use information into environmental decision-making
  - Performs best with detailed, high resolution land use data.
- First applied in So. California
  - Completed for Southern California and the Ba Area (16 counties; 76% of population)
  - In process in 5 southern Central Valley counties.
- Screen and map where people are exposed
  - Residential land use
  - Sensitive land use categories (California ARB land use guidelines, 2005)

Categories of Impact & Vulnerability

- Proximity to hazards & sensitive land uses
  - Based on EJ literature
  - CARB land use guidelines (sensitive receptors)
  - State data on air quality hazards
- Health risk & exposure
  - Based on EJ and public health literature
  - Available state and national data
  - Modeling from emissions inventories
- Social & health vulnerability
  - Based on epidemiological literature on social determinants of health
  - Based on EJ literature on area-level measures of community vulnerability

Screening Method Architecture

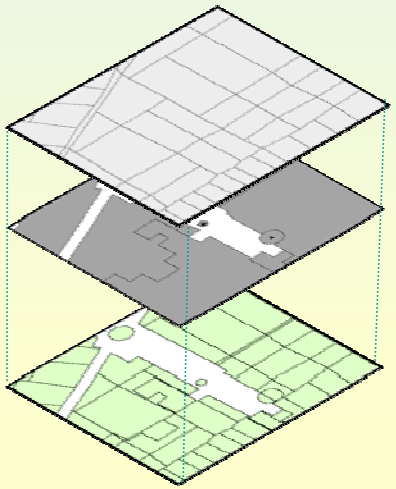


- **Step 1:** GIS Spatial Assessment
  - Derivation of land use layer
  - Create CI polygon mapping layer (intersects land use polygons with census blocks)
  - Identify land use and hazard proximity metrics for CI polygons
- **Step 2**: Programming (SPSS)
  - Data processing and cleaning
  - Metrics development
  - Derivation of CI scores
    - By category (Risk, hazard proximity, SES)
    - Total CI score
  - Analytics
    - This work can be done in SAS or R
- **Step 3:** GIS Mapping of Results
- Essential to Steps 1 - 3:
  - Quality control of data layers
  - Document and verify metric derivation and scoring
  - Scientific and Community peer review

GIS Spatial Assessment –
Derive Land Use Spatial Layer

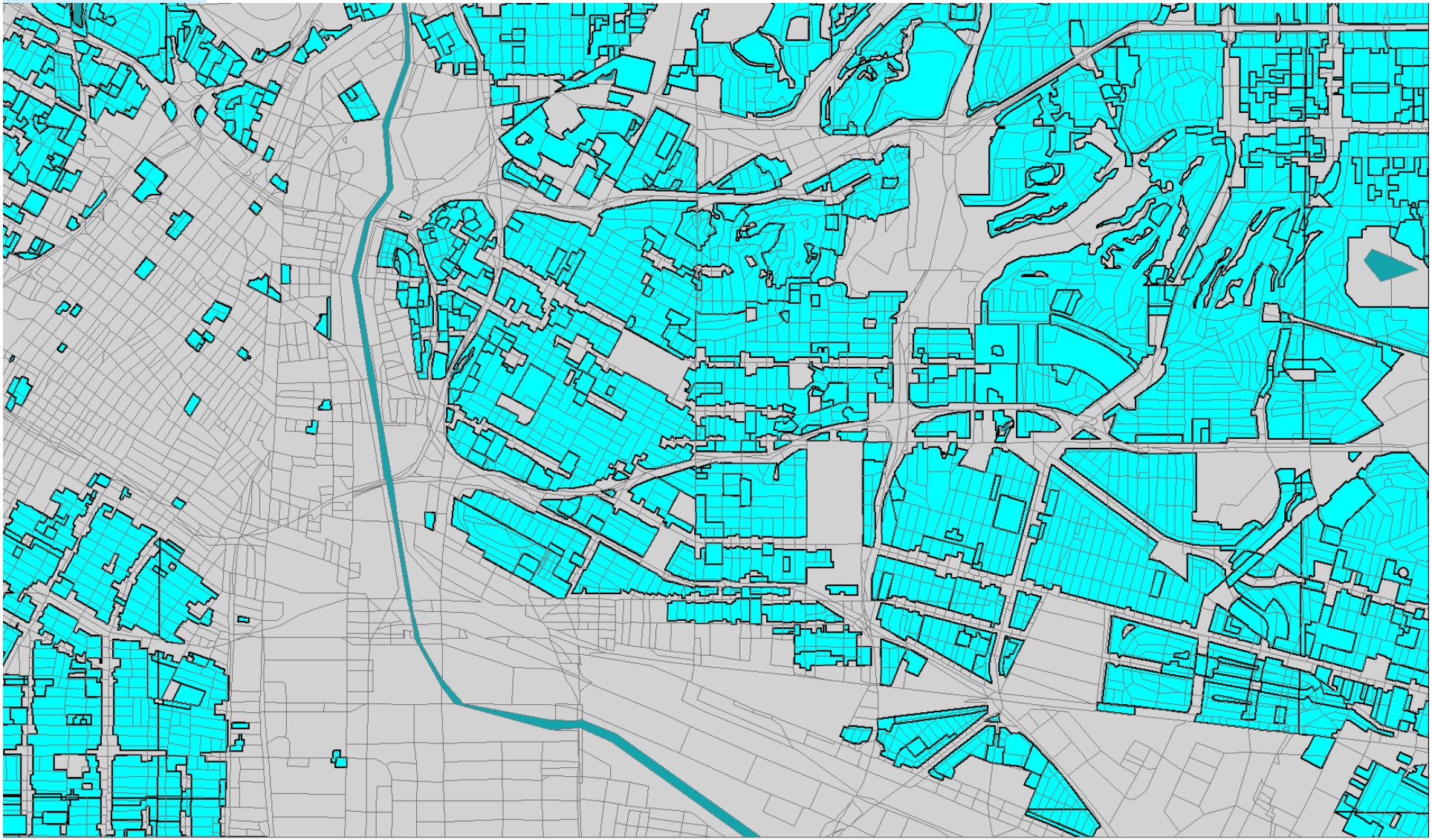
1. Create land use layer by isolating specific land uses
   - "Sensitive land uses" – daycare, schools, medical facilities, senior housing, urban parks and playgrounds(CARB, 2005)
   - Residential

2. Intersect land use polygons with census blocks

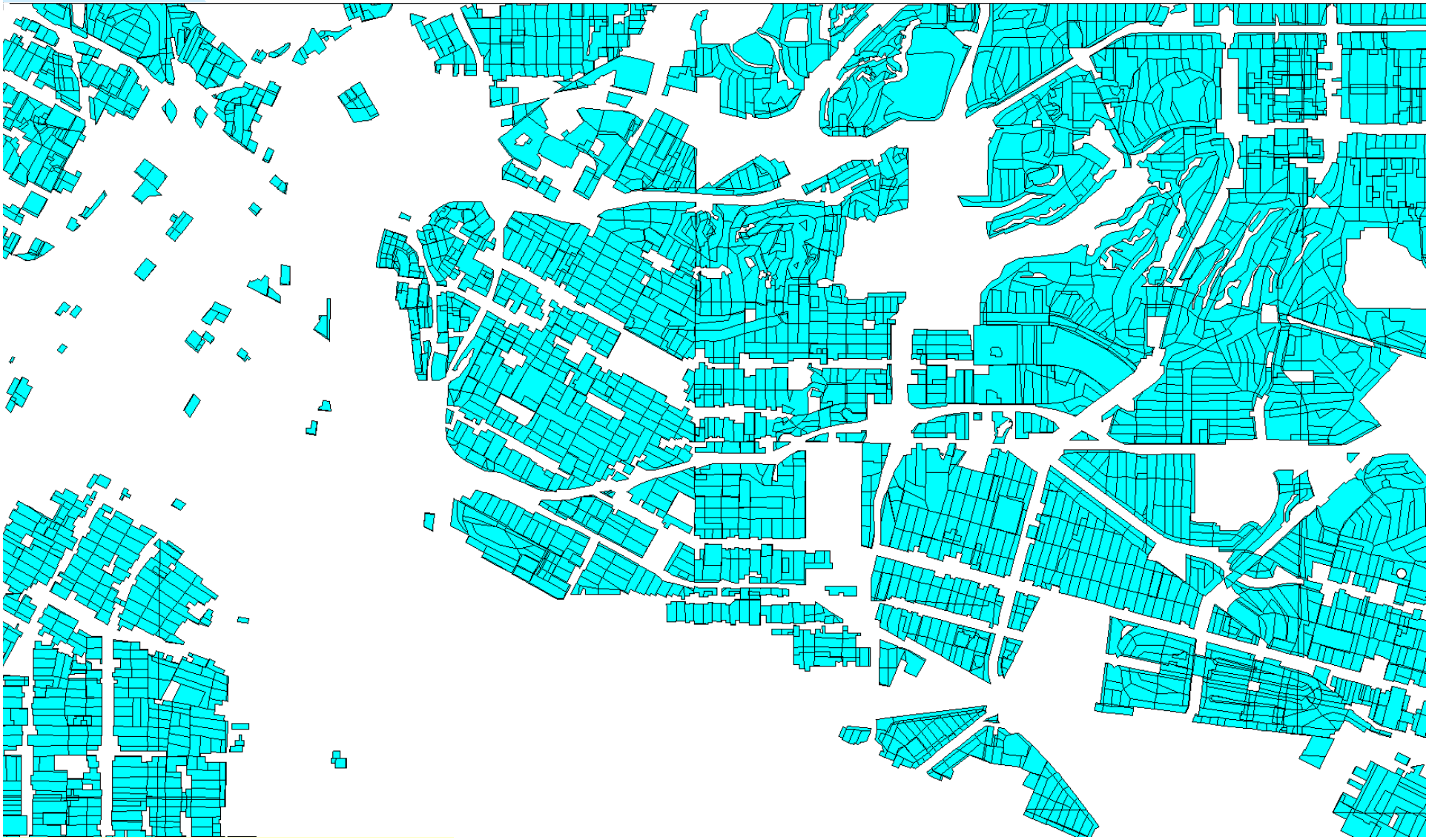


3. Resulting Base Map - CI Polygons
   - Scoring System – each polygon receives "points" related to indicators
   - Final mapping also done using census tracts (discussed later)

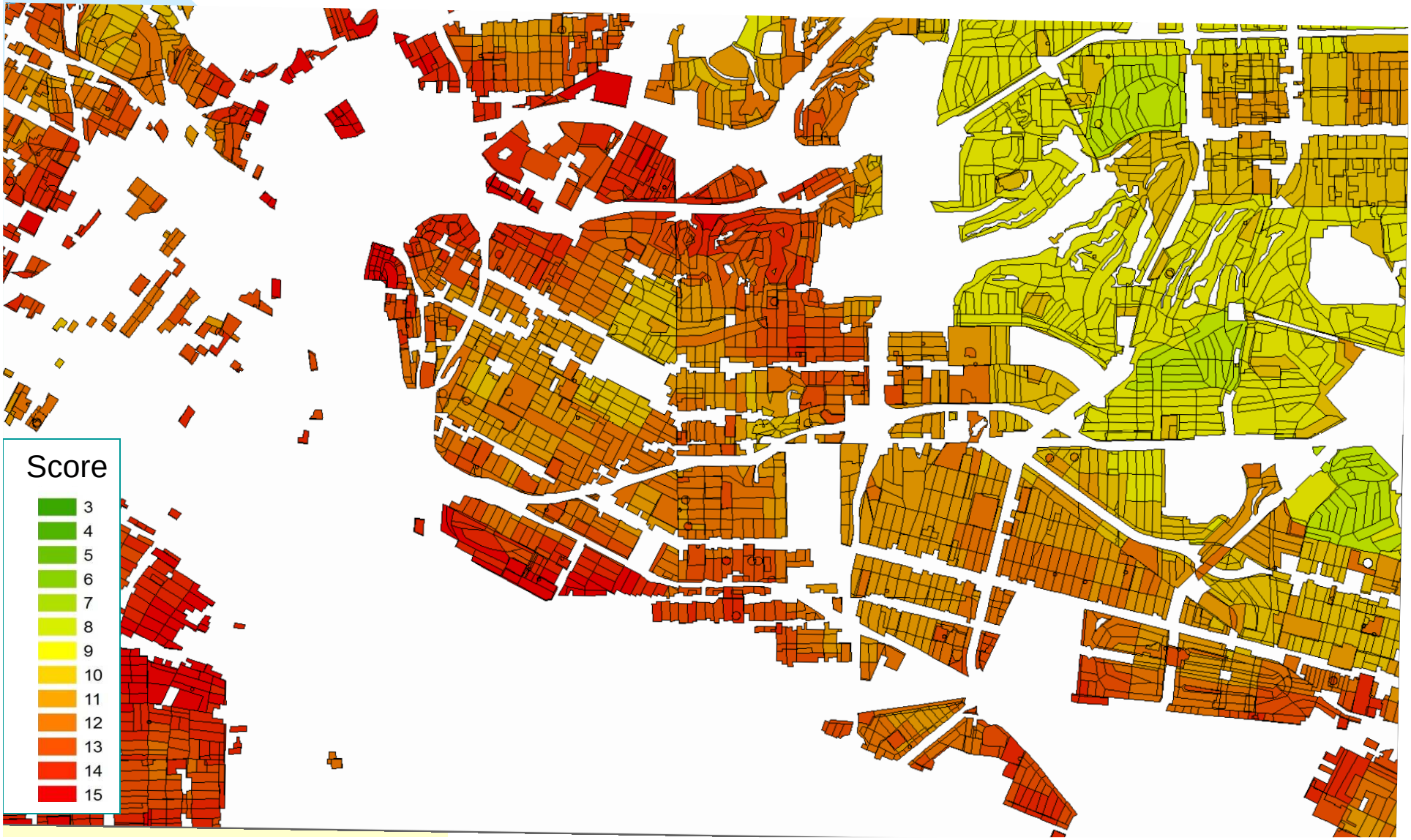
Intersect Land Use Polygons with Blocks



Result: Cumulative Impact (CI) Polygons, each associated with a specific block and land use



Each CI Polygon receives a Cumulative Impacts Score



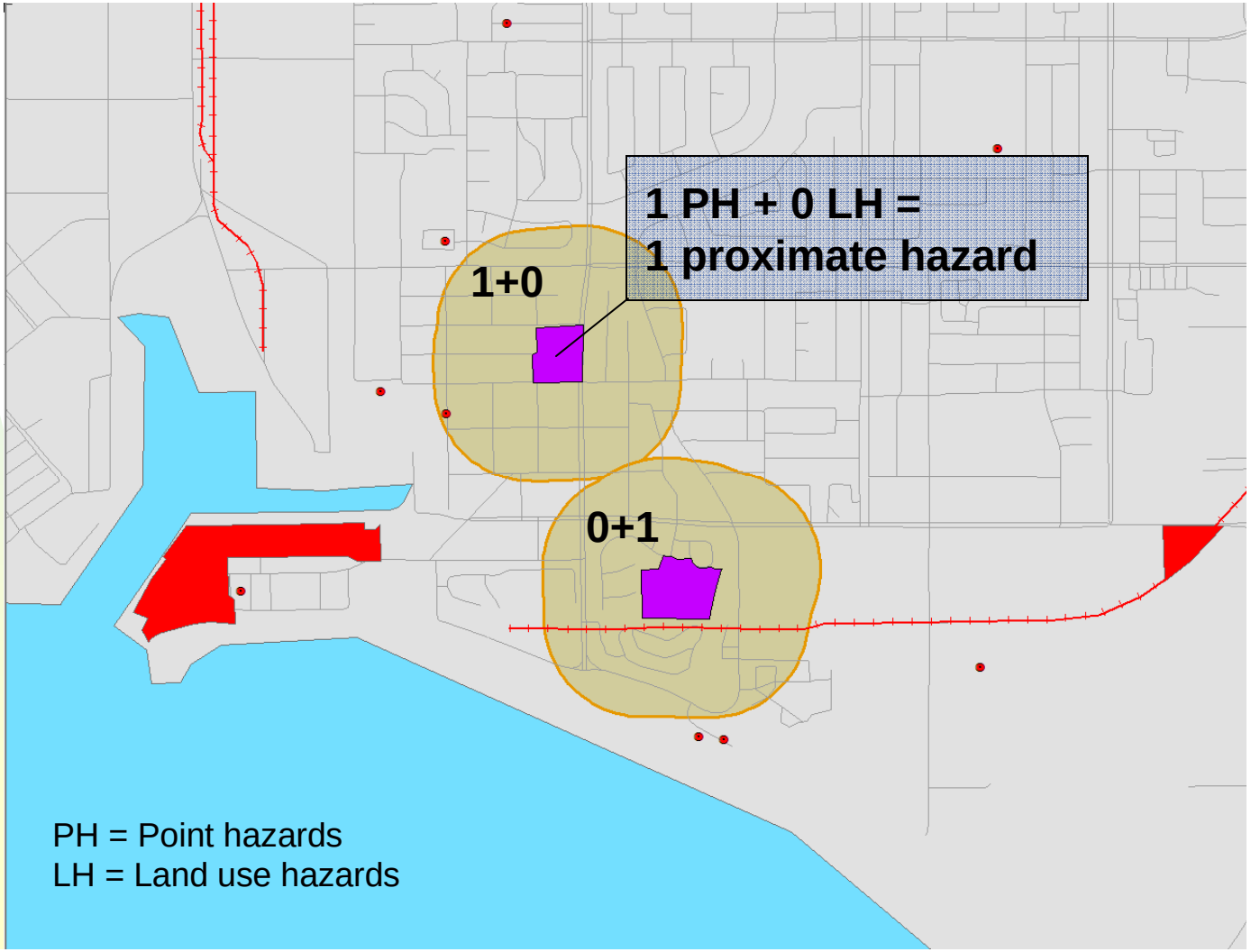
Scoring – Land Use and Hazard Proximity

- Land use polygons receive a score of 1 if they contain at least one sensitive land use category
- Calculate hazard proximity metrics
  - CHAPIS (Priority emitters from California emissions inventories)
  - Chrome Platers
  - Hazardous Waste TSDs
  - Land Uses associated with high levels of air pollution (ARB Handbook)
    - Rail, Ports, Airports, Refineries, Intermodal Distribution Facilities
    - Traffic counts (CARB land use “freeways and high traffic roads”)
- Proximity analysis using CI polygons
  - Number of sites within distance of CI polygon boundary
  - Distance-weighted approach to address locational inaccuracy

- Transfer values to census tracts using a population-weighting procedure

Defining Hazard Proximity
Distance-weighted Approach

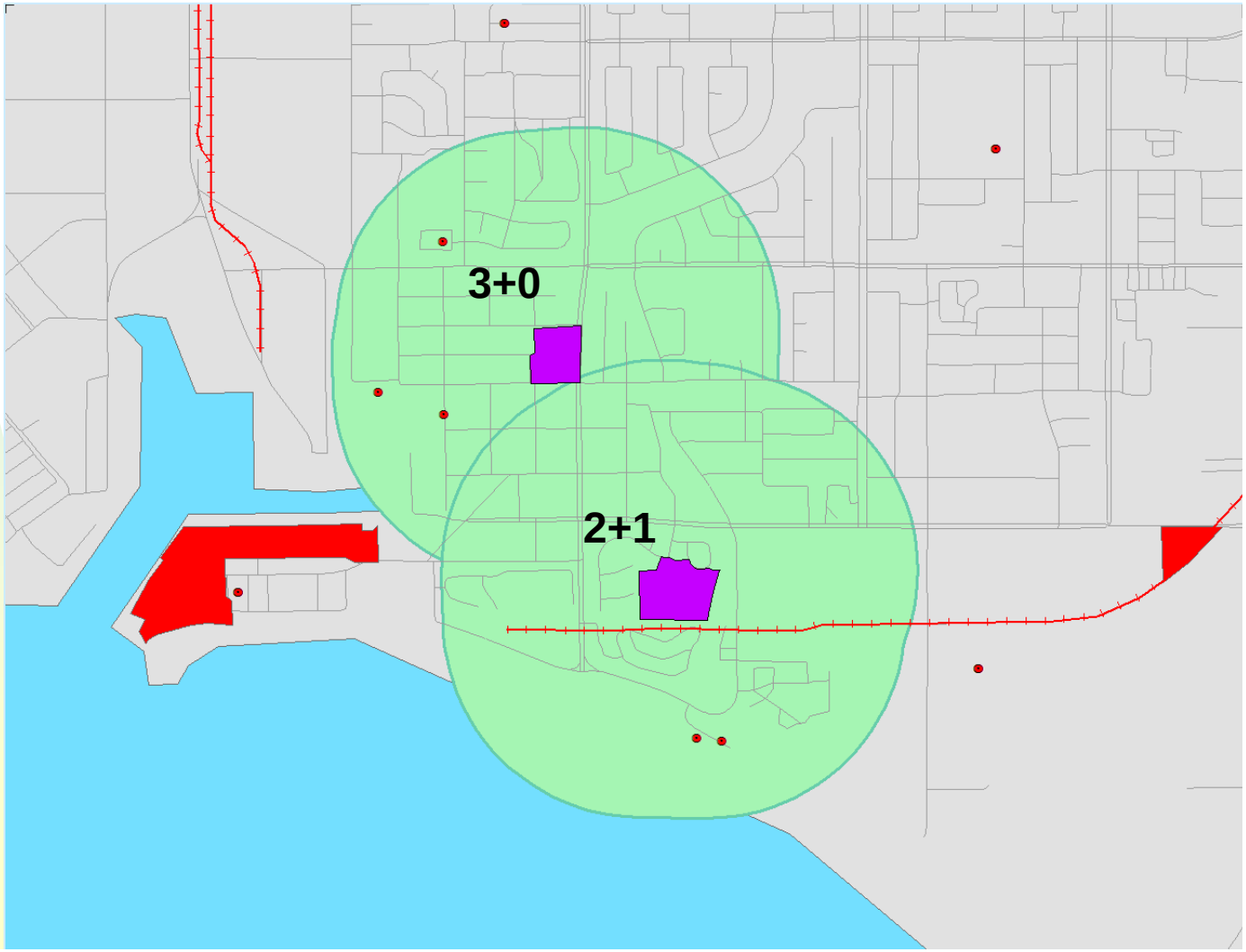
- Buffer CI polygon boundaries at different distances
- Hazard proximity based on number of facilities (point-sources) and hazardous land uses inside the buffer



Defining Proximity – Distance Buffers

2000 Foot Buffer

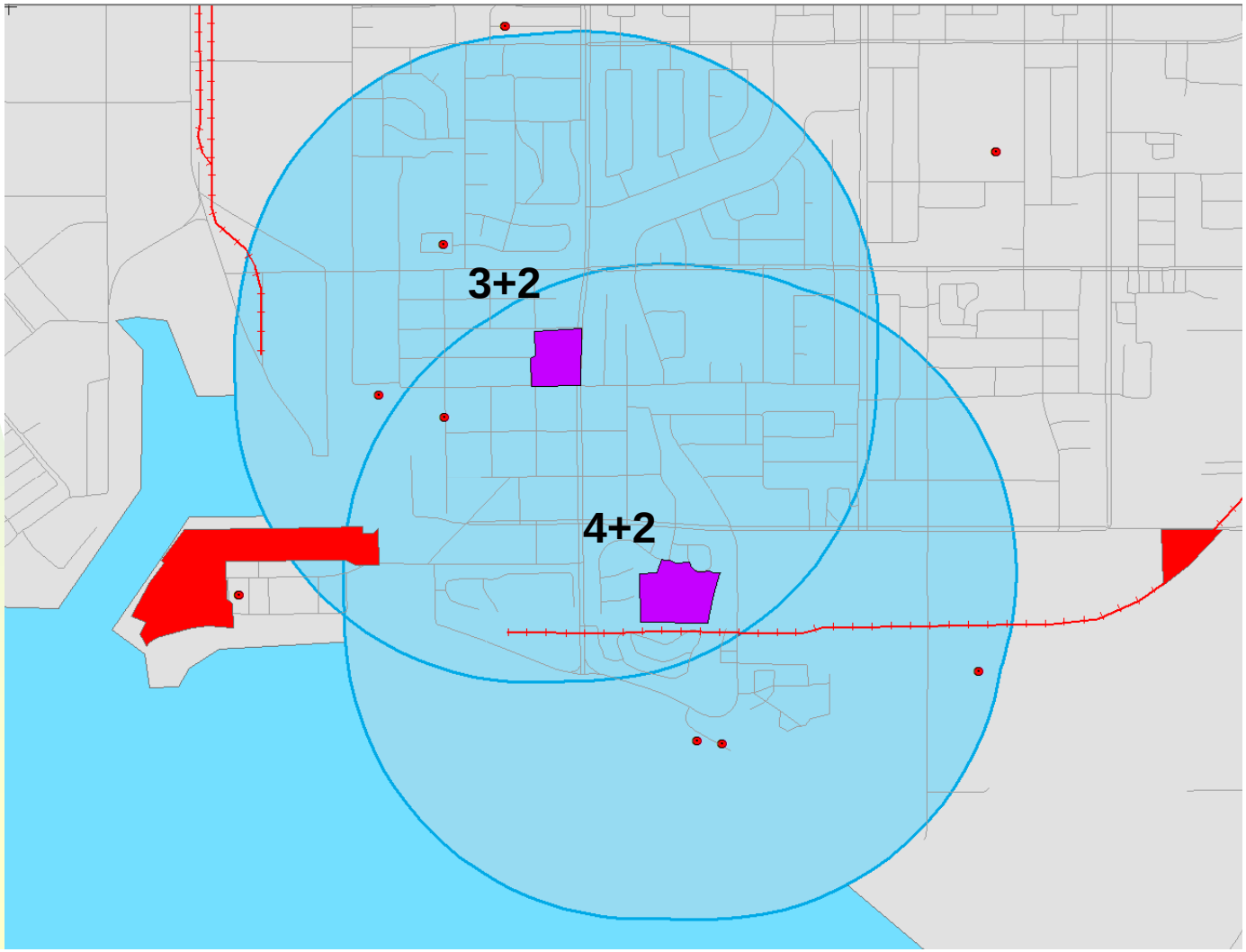
- Buffer CI polygon boundaries at different distances
- Hazard proximity based on number of facilities (point-sources) and hazardous land uses inside the buffer



Defining Proximity – Distance Buffers

3000 Foot Buffer

- Buffers on CI polygon boundaries
- Hazard proximity based on number of facilities (point-sources) and hazardous land uses inside the buffer



Distance Weighting the Hazard Count

Because of the potential for inaccurate hazard locations, a distance weighted approach is used to get the hazard count for each CI polygon:

Distance Weighted Hazard Count =

(1 x #Hazards within 1,000ft) +

(**0.5** x #Hazards 1,000-2,000ft) +

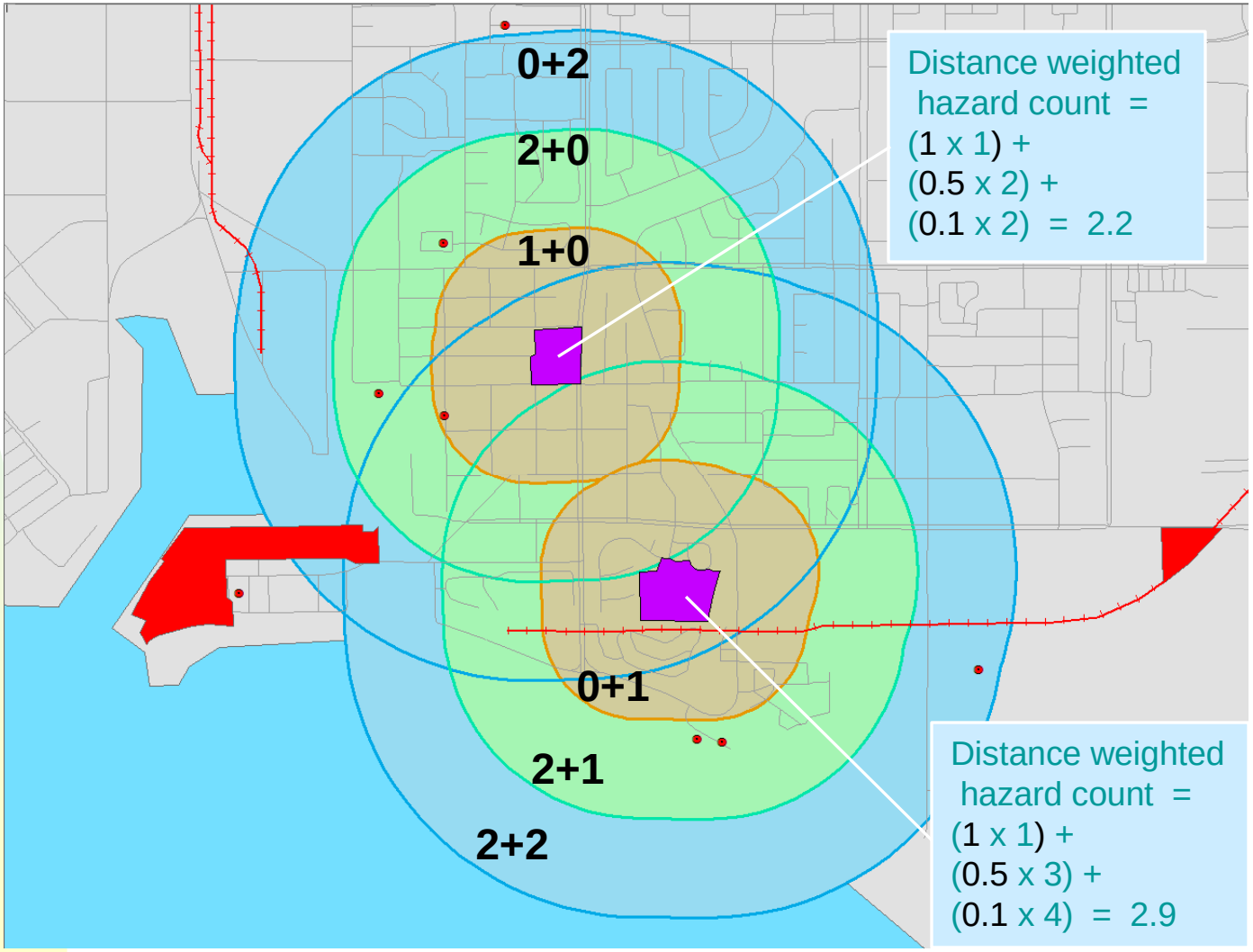
(**0.1** x #Hazards 2,000-3,000ft)

* *The above* ***weights*** *can be set to any desired value*

Defining Proximity – Distance Buffers

1000-3000 Foot Buffers, Distance Weighted Hazard Count

- Buffer CI polygon boundaries at different distances
- Hazard proximity based on number of facilities (point-sources) and hazardous land uses inside the buffer



Next Step: Calculate Hazard Proximity & Sensitive Land Use Counts at the Tract Level

Why?

- Tracts are a consistent level of geography for many sources of data
- All of the health risk and social vulnerability measures (discussed later) are available at the tract level

How Calculated:

- Estimate population in each CI polygon (area-weighting from census blocks)
- Calculate population-weighted average of the hazard and sensitive land use counts using all CI Polygons in each census tract

Scoring: Hazard Proximity & Sensitive Land Use

- Tract-level hazard are ranked into quintiles (1-5) across all tracts in the region to produce the final hazard proximity and sensitive land use **score**

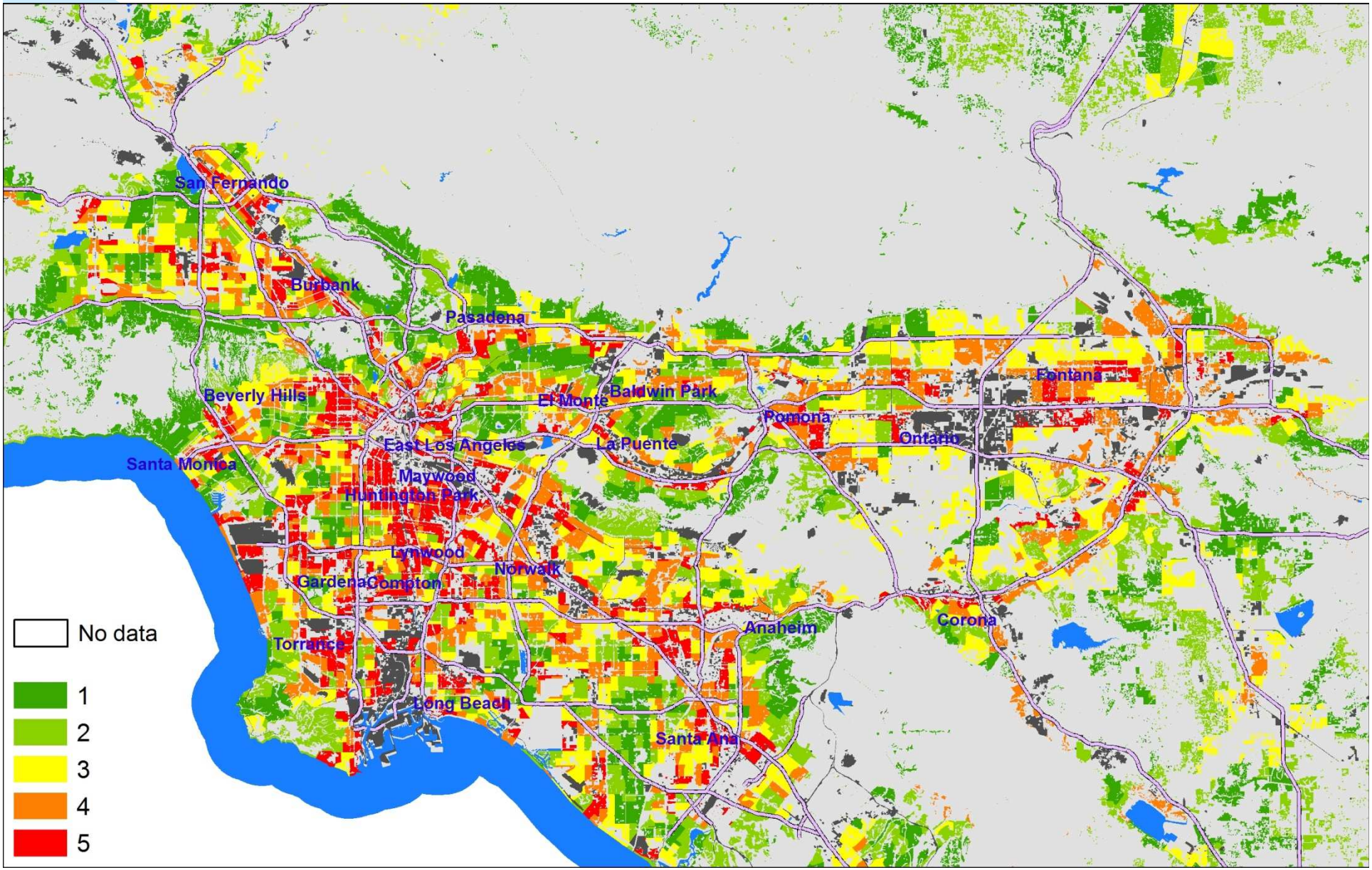
- Quintile distribution is used throughout the EJ Screening Method because it is an easily understood and normal ranking procedure

  - No “right” distribution to follow (magnitudes of hazards unknown)

  - Other distributions could easily be applied

Hazard Proximity & Sensitive Land Use Score at the Tract Level

Mapped on CI Polygons (quintile distribution)



Scoring for Health Risk & Exposure
(Tract Level)

Five indicator metrics, all at tract level

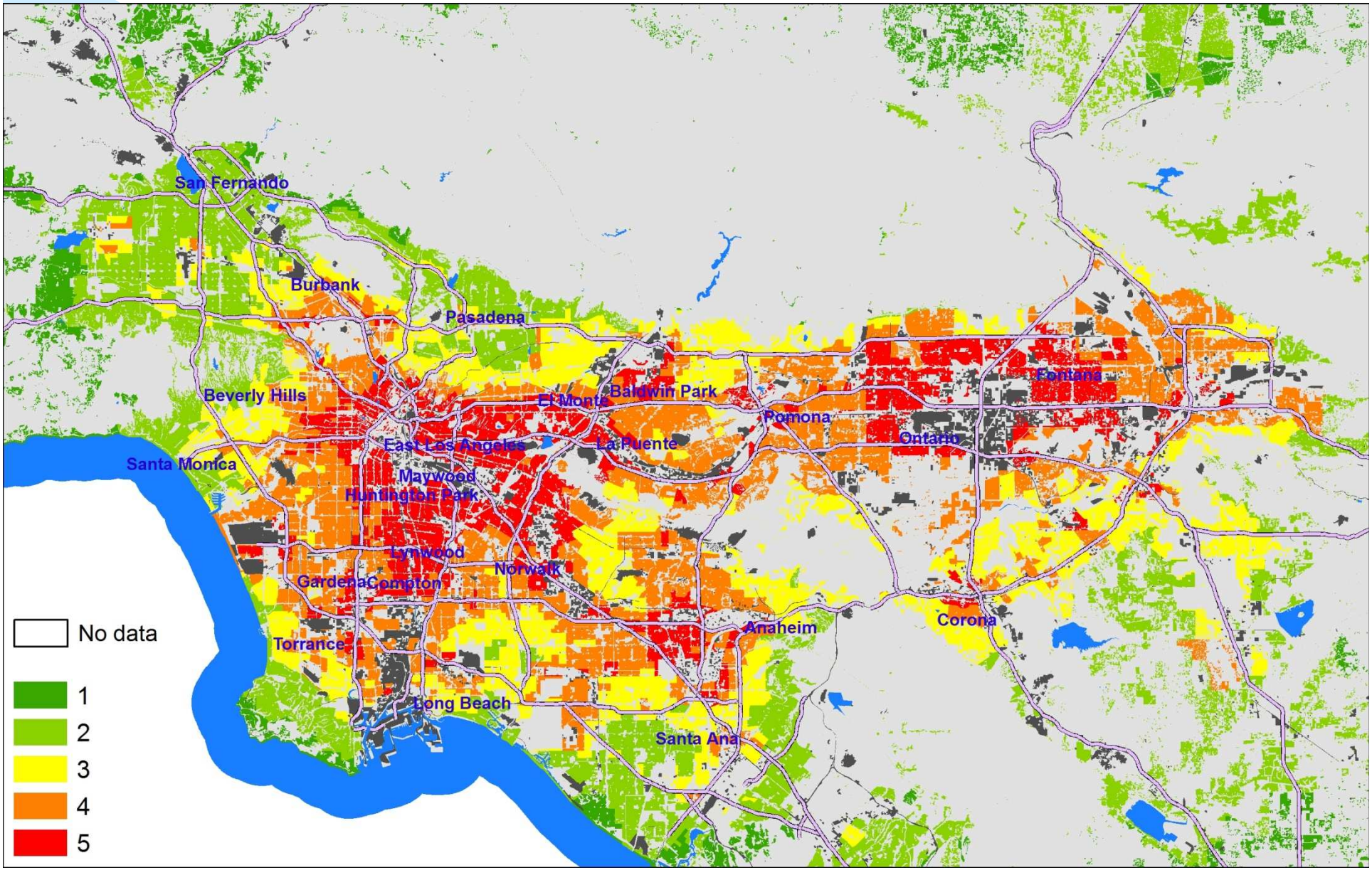
- RSEI - Toxic conc. hazard scores from TRI facilities (2005)
- NATA - Respiratory hazard from mobile/stationary sources (1999)
- CARB Estimated Inhalation Cancer Risk 2001
- CARB estimated $PM_{2.5}$ concentration (2004-06)
- CARB estimated Ozone concentration (2004-06)

Scoring:

- Each indicator is ranked into quintiles (1-5) across all tracts in the region
- Quintile rank values are summed for each tract
- Tract-level sum is ranked into quintiles (1-5) across all tracts in the region
- The resulting quintile rank is the final health risk and exposure score for each tract

Health Risk & Exposure Score at the Tract Level

Mapped on CI Polygons (quintile distribution)



Social & Health Vulnerability Indicators

Census Tract Level Metrics (2000)

Socioeconomic Status/EJ

- % residents of color (non-White)
- % residents below twice national poverty level
- Home ownership - % living in rented households
- Housing value – median housing value
- Educational attainment – % population > age 24 with less than high school education

Biological/ Health Vulnerability

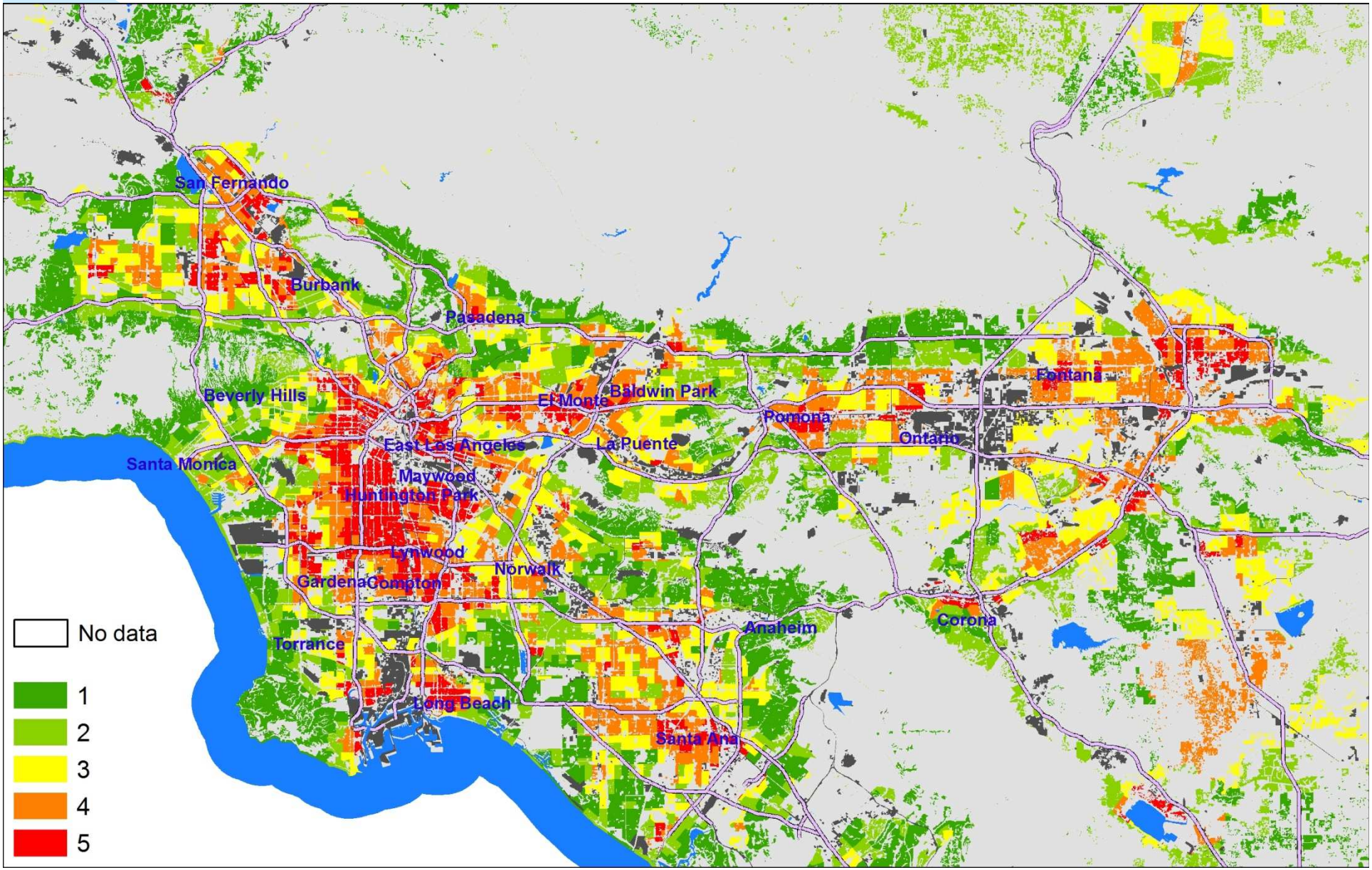
- Age of residents (% <5)
- Age of residents (% >60)
- Birth outcomes – % preterm or SGA infants 1996-03

Civic Engagement Capacity

- Linguistic isolation - % pop. >age 4 in households where no one >age 15 speaks English well
- Voter turnout - % votes cast among all registered voters in 2000 general election

Social Health & Vulnerability Score at the Tract Level

Mapped on CI Polygons (quintile distribution)



Social & Health Vulnerability Scores

- Each social and health vulnerability metric is ranked into quintiles (1-5) across all tracts in the region

- Final score is derived by taking average ranking (across all metrics) for each tract, and ranking the average once again into quintiles (1-5)

A note on missing values:
To help ensure that the social and health vulnerability scores are reliable, we exclude tracts with less than 50 people, and those with 5 or more missing values among the 10 metrics considered. To account for missing values in tracts with 1 to 4 missing metrics, the average quintile ranking is taken across only the non-missing metrics.

Final Cumulative Impact Scores

Combine three categories of impact and vulnerability to derive final Cumulative Impact Score

Cumulative Impact Score =

Hazard Proximity and Sensitive Land Use Score (1-5) +

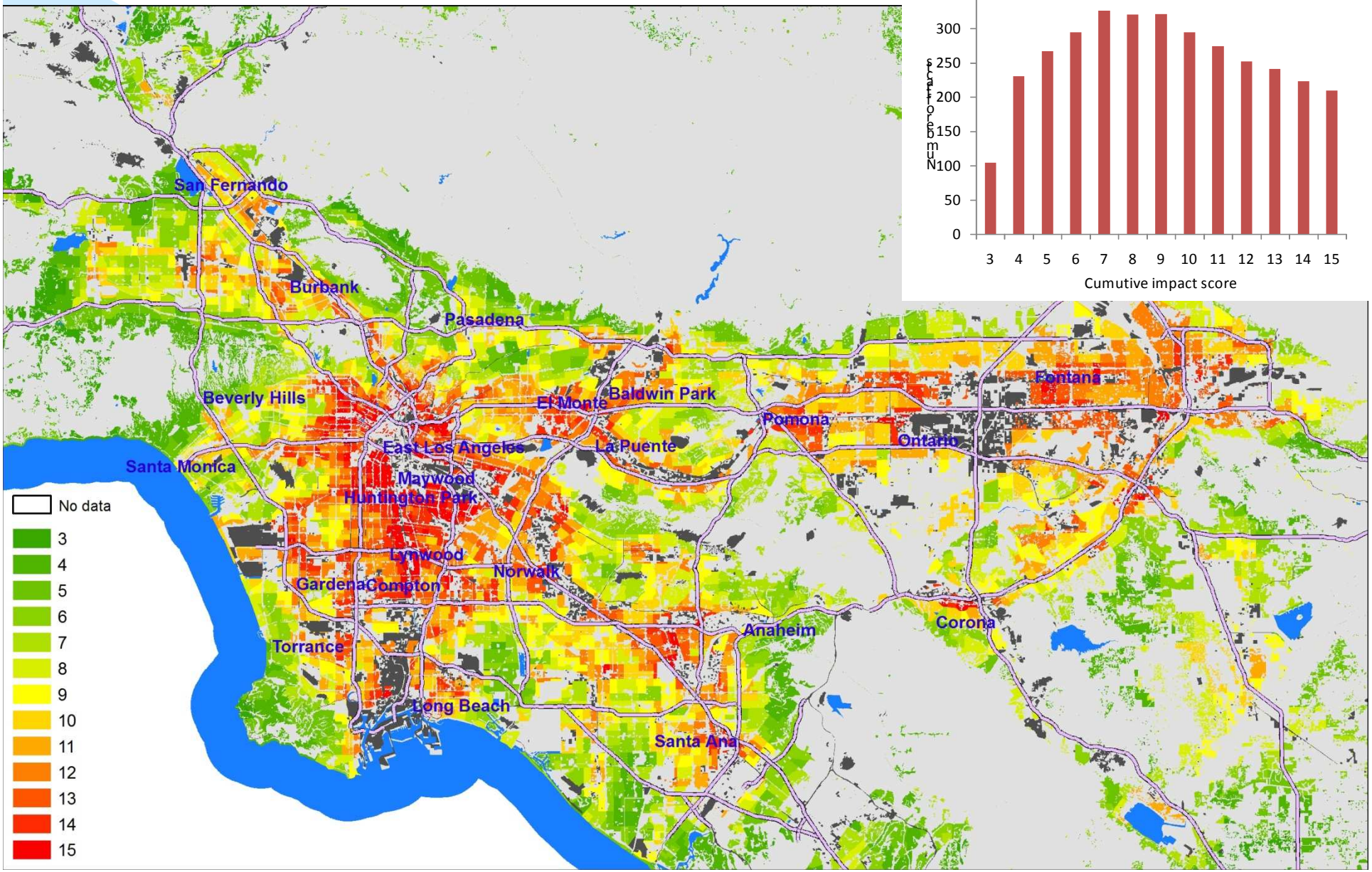
Health Risk and Exposure Score (1-5) +

Social and Health Vulnerability Score (1-5)

- *Final Cumulative Impact Score Ranges from 3-15*

Tract Level Cumulative Impact Score

Distance weighted hazard proximity, mapped on CI Polygons



Important Caveats

- Method was developed with specific reference to air quality and does not screen for other concerns (such as water quality or pesticides)
  - Performs best with well-classified, high spatial resolution land use data
    - Currently experimenting with other data types to apply the Screening Method more widely
  - This is screening not assessment, so neighborhood monitoring and ground truth verification is needed.